# CERES FLASHFlux Status: Progress toward Version 4A and New GIS-enabled Web Site

## Low Latency Surface Radiative Fluxes and Meteorological Parameters for Research and Applications

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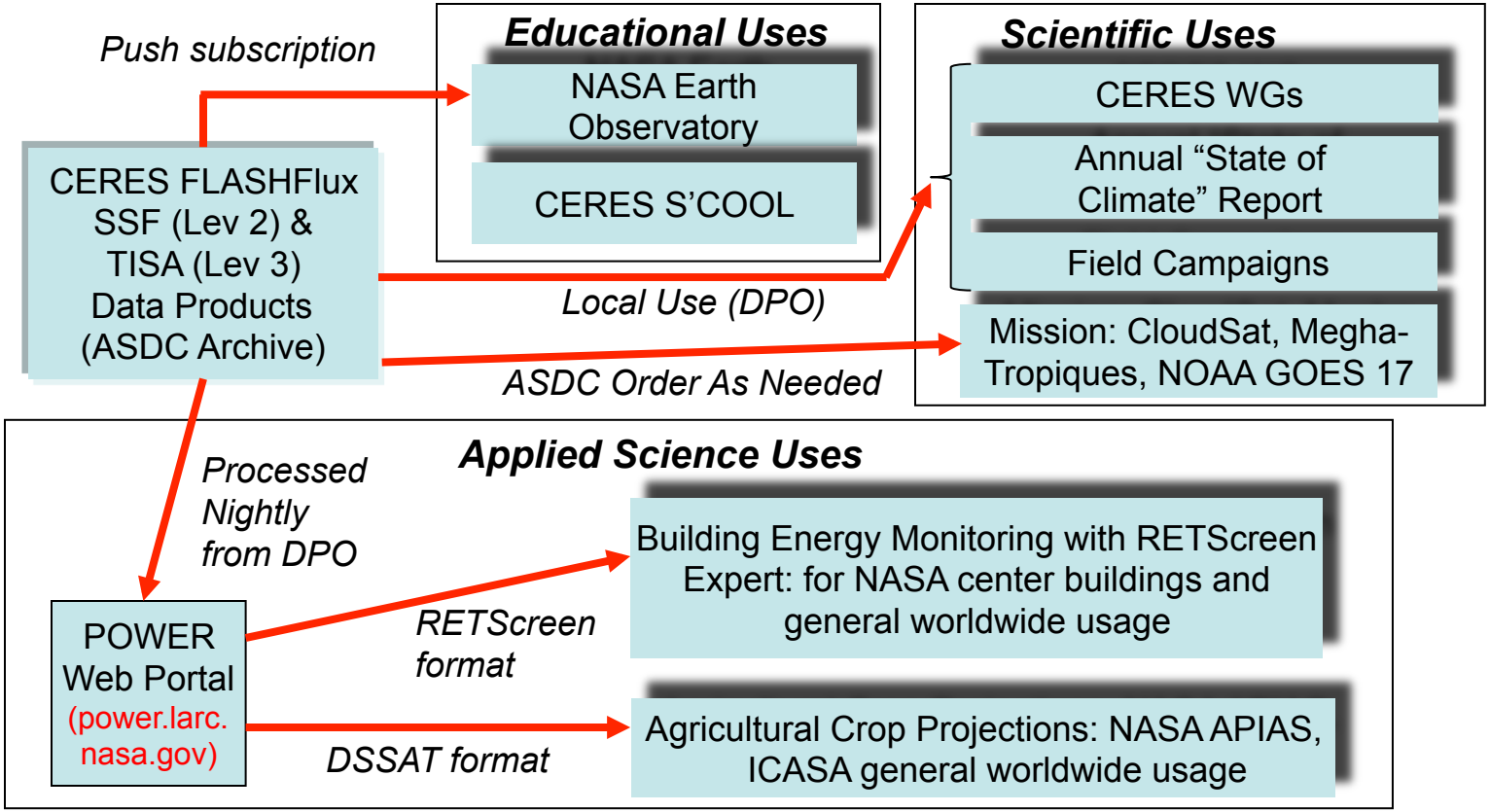
*Tonya Davenport and Fenny Wang and the Atmospheric Science Data Center Team (SSAI)*

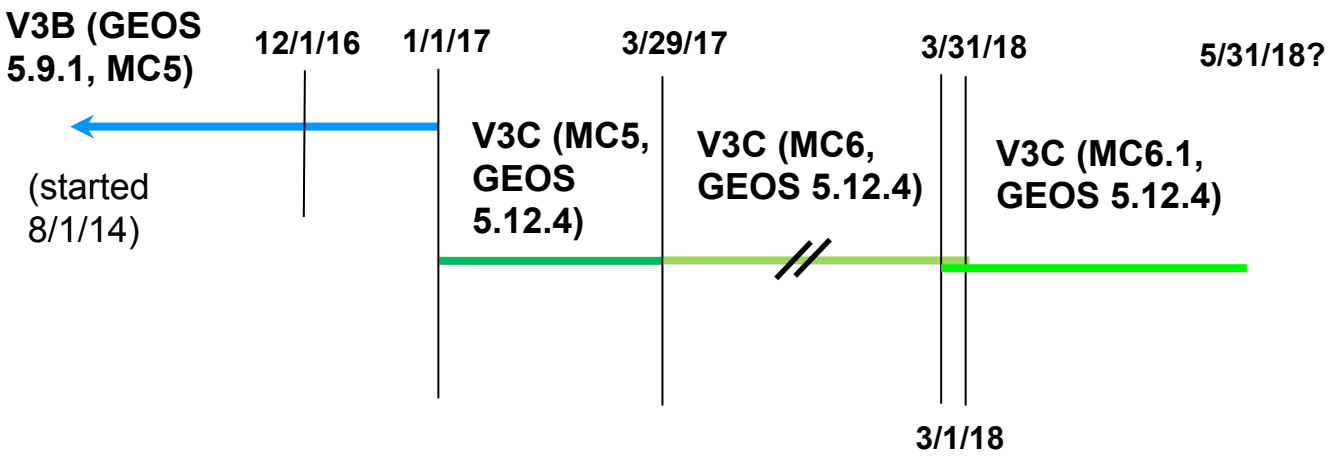
# FLASHFLUX: Schematic of Current Uses



# FLASHFlux v3C Status

- ***Production with v3C (MODIS C5/C6/C6.1) (since Jan 1, 2017)***
  - Now uses FP-IT (GEOS 5.12.4) and MODIS Collection 6.1 (after March 1, 2018)
  - FLASHFlux TISA available via CERES subsetter, ASDC and specialized formats through POWER web portal (power.larc.nasa.gov) 5-6 days latency
  - Plan to continue production for 2018 while production adapted to FF v4A
- ***Current Activities***
  - V3B v V3C and MODIS Coll. 5/6/6.1 differences evaluated; MC 6/6.1 shown here
  - Validation for v3C-MC6, v3C-MC6.1, v4A
  - Development towards V4A => V4A through FLASHflux SSF being tested (uses MC6.1)
- ***FLASHFlux Data Provision Through POWER:***
  - New POWER web portal in beta within days of release
  - Leverages OPeNDAP with both direct API and GIS-based Data Access Viewer
  - Multiple output formats supported => parameters aimed to specific usages
  - Hourly CERES SYN1Deg used for Canadian solar resource map and time series data supplied to partner performing building energy analysis

# Current FLASHFlux Versions

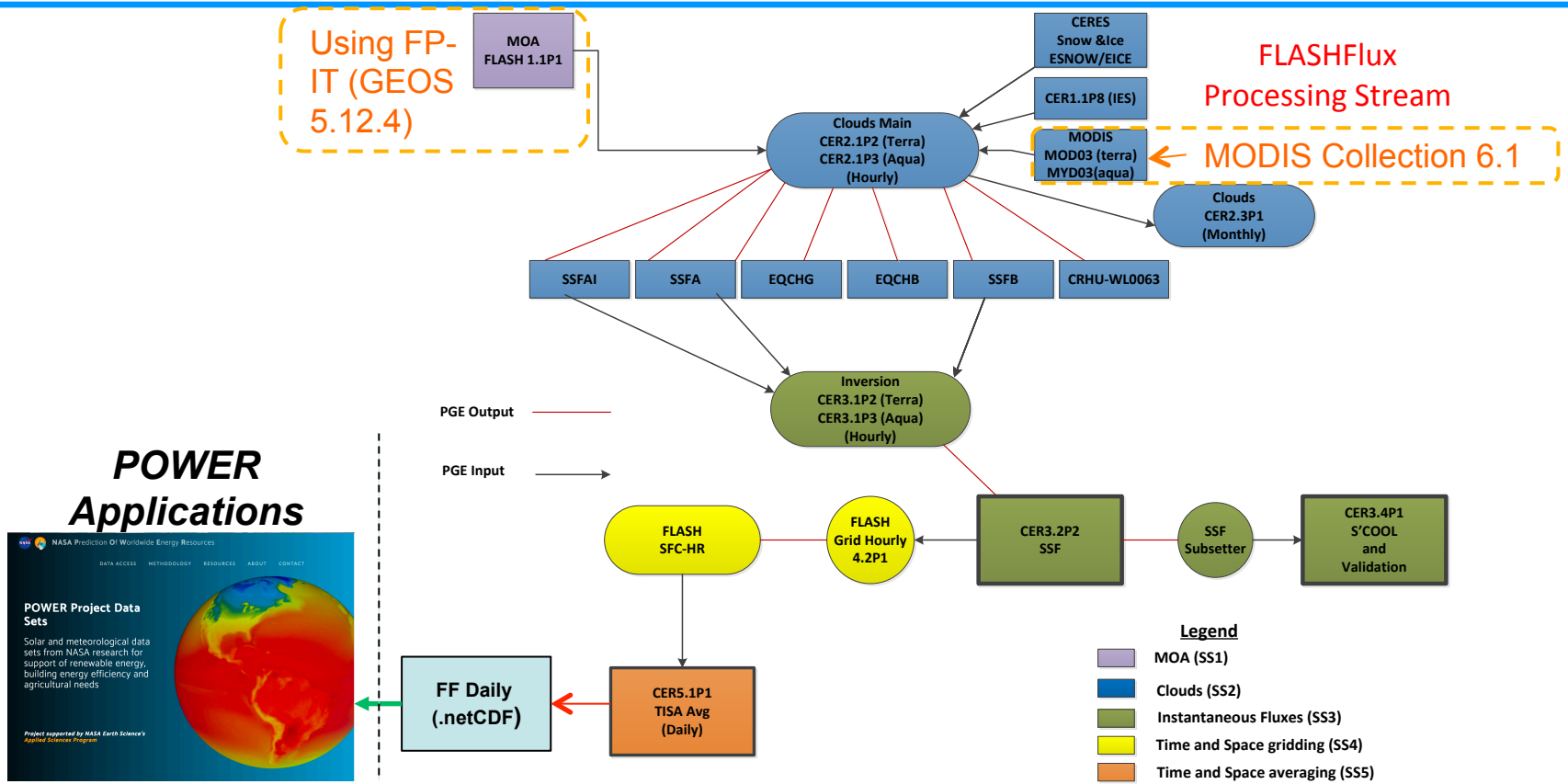



*Transitioned from MODIS Collection 6 to 6.1*

MC = MODIS Collection 5/6/6.1

GEOS = FP-IT version

# Current v3C Production System




## *POWER Applications*

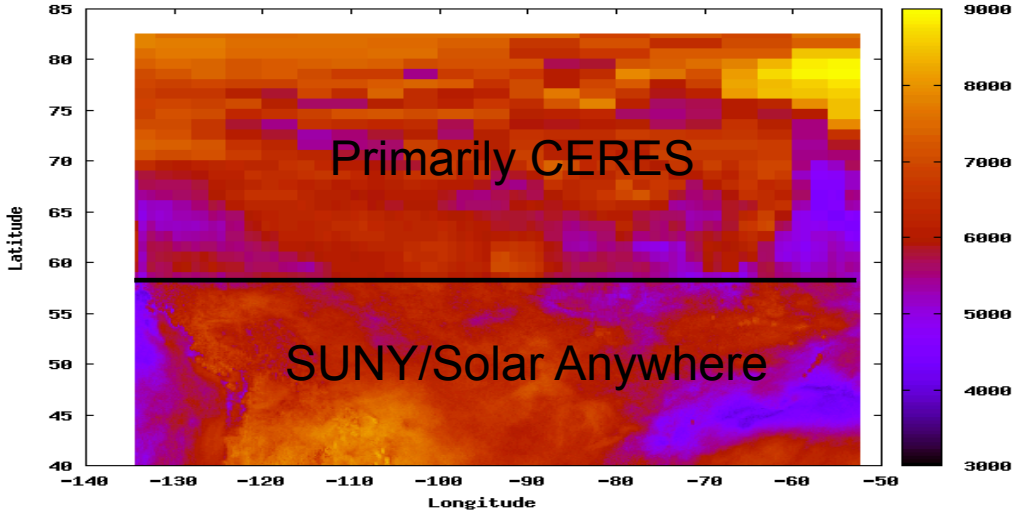
# POWER New (GIS) Featuring FLASHFlux Fluxes (https://power.larc.nasa.gov/new)

- **Using ArcGIS architecture** to geospatially enable entire POWER data archive for access to growing Applied Science users.
- **Increased spatial/temporal resolutions**:
  - Features CERES FLASHFLUX for Solar & GMAO MERRA-2/GEOS 5.12.4 for meteorological parameters
  - Mapped to ½ x ½ spatial resolution, Low latency Daily Time Series, 30 Year Climatological Averages
- ***Complete API service (data order using URL)***
  - allows for data to be repeatedly requested using a script or from within a user analysis program
- ***Interactive Data Access Viewer and ArcGIS Image Services***
  - User selection of location, parameters
  - Output formats ASCII, CSV, geoJSON, NetCDF4, ICASA, GeoTiff

# New CERES Application Highlights

- ***SYN1Deg hourly SW used for Canadian Solar Resource Maps***
  - Natural Resources Canada commission Dr. Richard Perez (SUNY-Albany) to develop new hourly solar resource for Canada. His algorithm uses GEO and cuts off at 58° N.
  - CERES SYN1Deg blended with his product to develop the new resource maps that are still under refinement and assessment
- ***SYN1Deg hourly SW used for building energy modeling project***
  - POWER team processed and delivered SYN1Deg 15 year time series data for selected locations
  - Data will be used to evaluate building energy models

**Preliminary Map:**
**Solar Irradiance for June 2006**




*Units: W-hr m$^{-2}$ day$^{-1}$*

# RETScreen/POWER Applied Science Benefits the U.S.

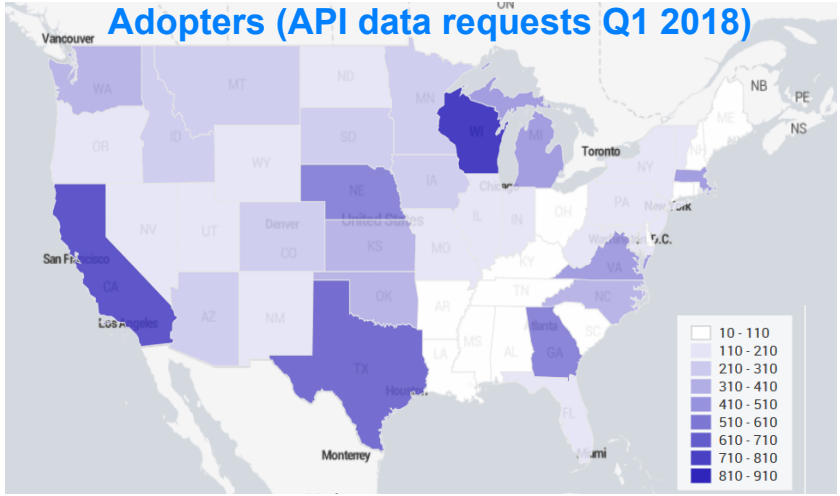
- *Michigan:* University of Michigan uses RETScreen to monitor building energy efficiency and greenhouse gas emission (uses POWER low latency data products from the GMAO and CERES FLASHFlux) (now Auburn U.) ( https://www.linkedin.com/pulse/universities-colleges-reduce-carbon-gregory-j-leng/)

- *Alaska:* U.S. Department of Agriculture Analyzes Wood Heating in Alaska with RETScreen (uses POWER daily long-term time series data product streams from the GMAO and CERES FLASHFlux) (https://www.fs.fed.us/pnw/pubs/pnw_gtr924.pdf)

- *Massachusetts and Minnesota:* RETScreen used to developed renewable energy heating and cooling scenarios for policy incentive programs including solar hot water heating, biomass heat and advanced heat pump technologies (uses POWER/SSE climatology data from GEWEX SRB, CERES, GMAO). ( http://www.mass.gov/eea/docs/doer/pub-info/heating-and-cooling-in-aps.pdf; http://mn.gov/commerce-stat/pdfs/value-solar-heating-cooling.pdf)

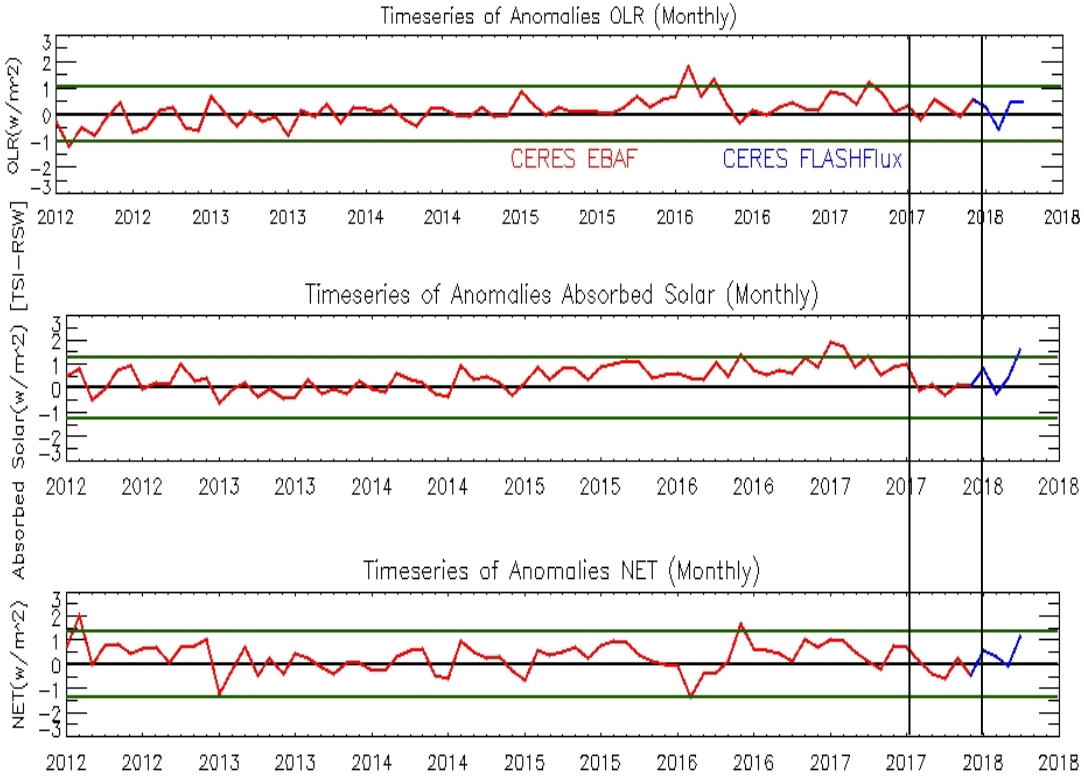
- *Hawaii:* Department of Education implementing program to use RETScreen at all education buildings/schools (POWER low latency data product from GMAO and CERES – new no documentation yet available)

## US Distribution of Early POWER-GIS Beta Adopters (API data requests Q1 2018)




- *Wisconsin:* RETScreen is used extensively for the State's Focus on Energy solar hot water incentive program for businesses. Potential projects are evaluated for savings using RETScreen (uses POWER/SSE climatology data from GEWEX SRB, CERES, GMAO). Other state uses include educational ( https://aefis.wisc.edu/index.cfm/page/AefisCourse.ABETSyllabusForm?courseid=848) ***and feasibility analysis*** ( https://psc.wi.gov/Pages/Programs/OEI.aspx/docview.asp).

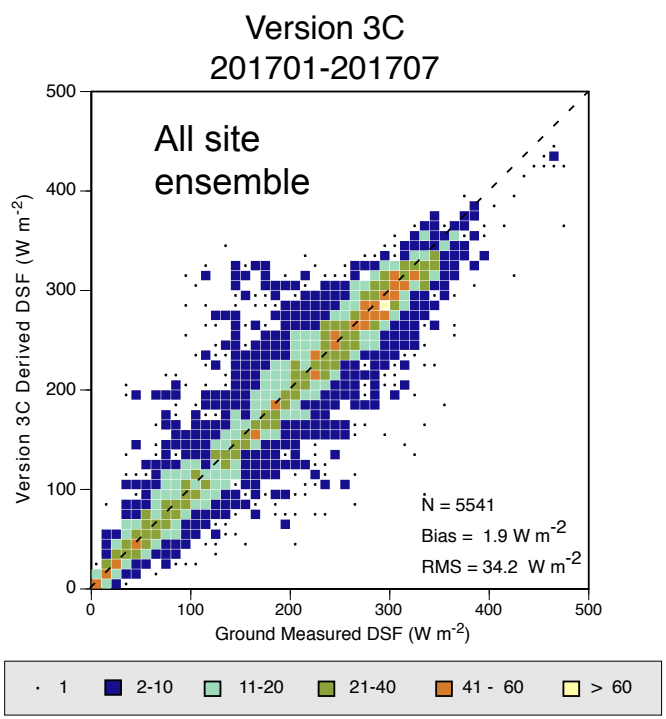
# Updated Global Anomaly Time Series




"State of the Climate 2017"
(Wong et al, submitted March 2018)

| | Global-annual Mean Difference (2017 minus 2016) (W m$^{-2}$) | 2017 Anomaly (relative to Clima-tology) (W m$^{-2}$) | Inter-annual variabil-ity (2001 to 2016) (W m$^{-2}$) (2-sigma) |
|---|---|---|---|
| OLR | +0.00 | +0.50 | ±0.60 |
| TSI | -0.10 | -0.10 | ±0.15 |
| RSW | -0.05 | -0.80 | ±0.80 |
| Net | +0.05 | +0.20 | ±0.75 |

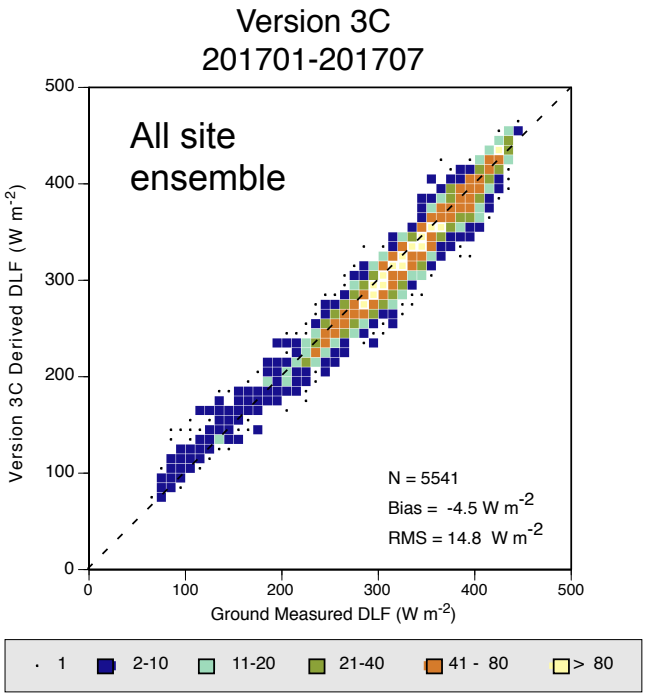
# Recent SW Validation: 1/2017– 7/2017




**Daily Averaged TISA Comparison**

| Ensemble Type | Bias ($W\ m^{-2}$) | RMS ($W\ m^{-2}$) | N |
|---|---|---|---|
| All Obs | 0.9 | 34.2 | 6319 |
| Continental | -5.8 | 28.4 | 1890 |
| Coastal | -3.1 | 28.5 | 1474 |
| Desert | 2.4 | 24.4 | 570 |
| High Latitude | -30.8 | 57.4 | 179 |
| Island | 1.1 | 22.4 | 349 |
| Buoy | 13.6 | 43.9 | 1857 |

# Recent LW Validation: 1/2017 –7/2017



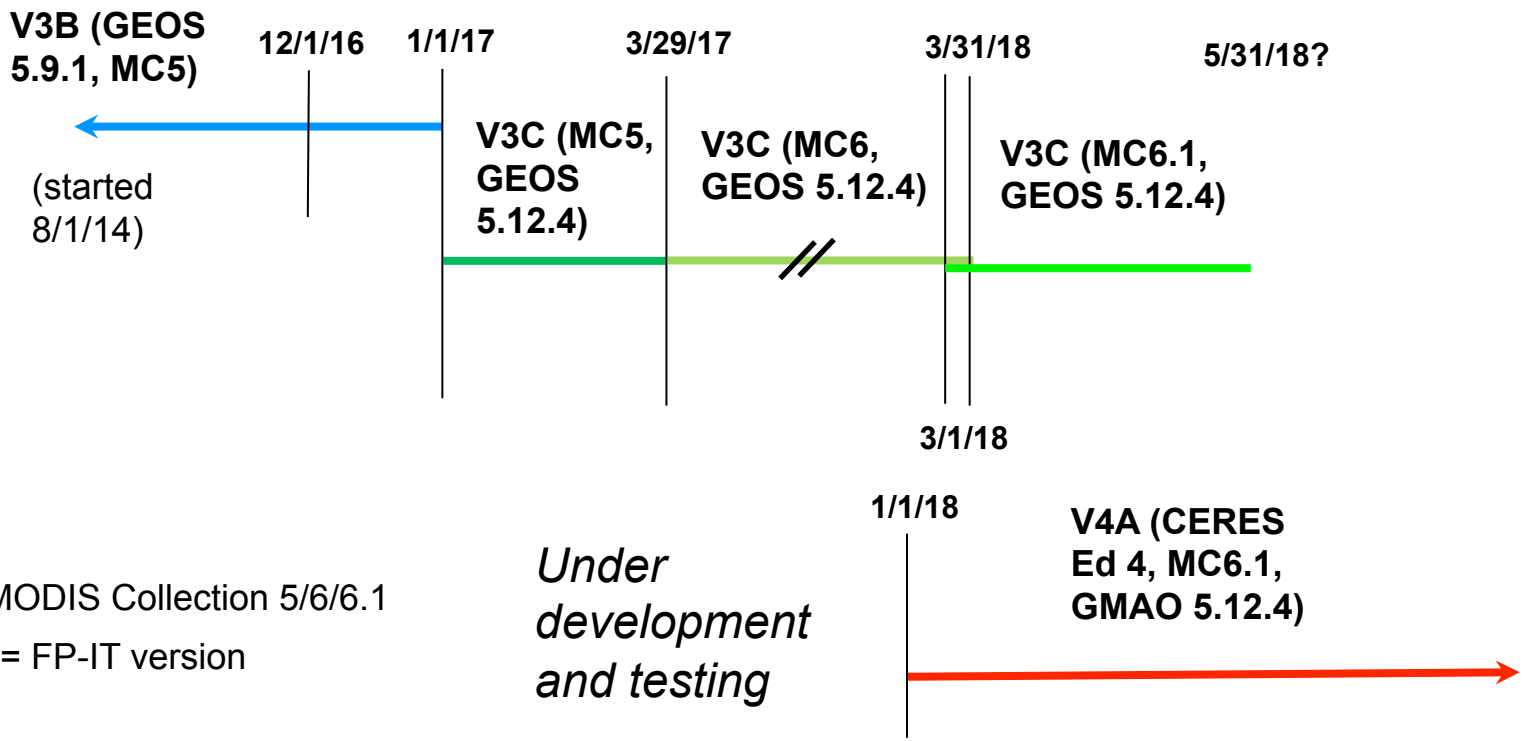

**Daily Averaged TISA Comparison**

| Ensemble Type | Bias ($W\ m^{-2}$) | RMS ($W\ m^{-2}$) | N |
|---|---|---|---|
| All Obs | -4.5 | 14.8 | 5541 |
| Continental | -9.0 | 16.0 | 1849 |
| Coastal | -1.8 | 12.2 | 1475 |
| Desert | -5.6 | 14.4 | 563 |
| High Latitude | 7.4 | 17.8 | 323 |
| Island | 0.5 | 9.2 | 350 |
| Buoy | -5.4 | 16.6 | 981 |

# Near Future: Moving FLASHFlux Toward V4

| Attribute | FF v3C (MC6) | FF v4A | FF v4B |
|---|---|---|---|
| Baseline 1QC | Previous | New calibration | New calibration |
| GEOS FP-IT input | GEOS 5.12.4 | GEOS 5.12.4 | GEOS 5.12.4 |
| MOA | Ed 4 compatible | Ed 4 compatible | Ed 4 compatible |
| MODIS | Collection 6 | Collection 6.1 | Collection 6.1 |
| Clouds | Ed 2 | Ed 4 | Ed 4 |
| SIBi (Snow/ICE Brightness Index) | No | Yes | Yes |
| Inversion (improved ADMs) | Ed 2 | Ed 4 | Ed 4 |
| Aerosols | MATCH climatology | MATCH climatology | GEOS 5.12.4 |
| Flux Algorithms | Unchanged | Unchanged | A0, Ap adjustments; new clear-sky TOA & surface albedos (current work) |
| TISA | Ed 2 | Compatible w/ Ed 4 (current work) | Compatible w/ Ed 4 (custom CERES TSI?) |
| Data Processed | March 28 - present | Planned to begin 1/1/18 | None |
| Validation Results | 1/1/17 – 7/31/17 | --- | --- |

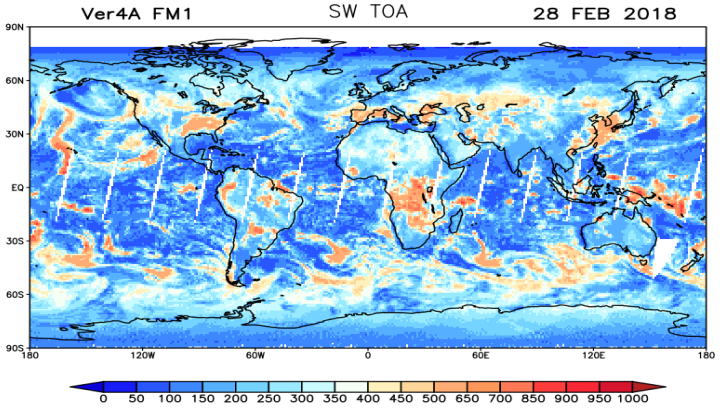
# Moving to FLASHFlux Ed4A

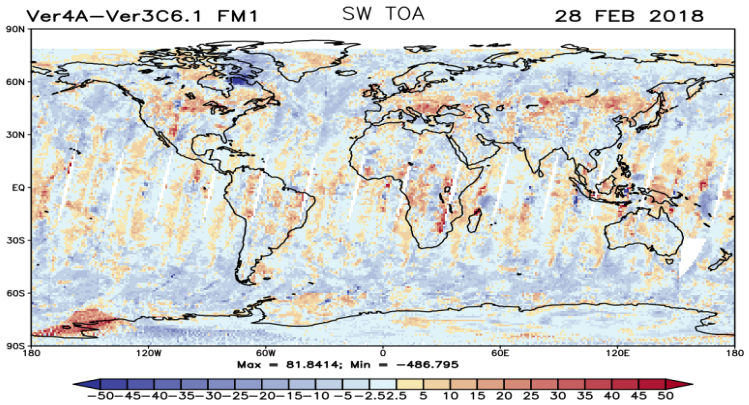



MC = MODIS Collection 5/6/6.1

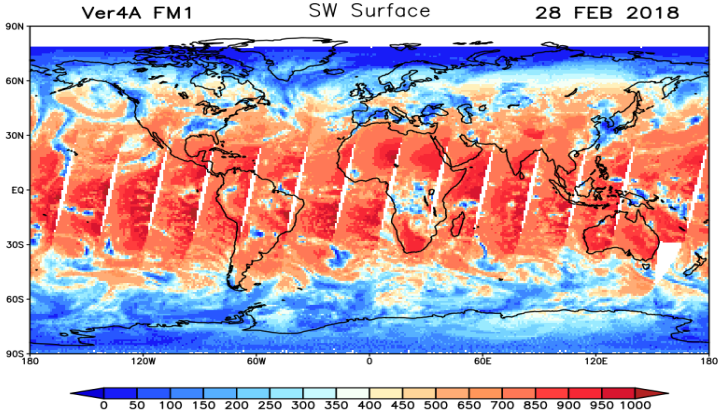
GEOS = FP-IT version

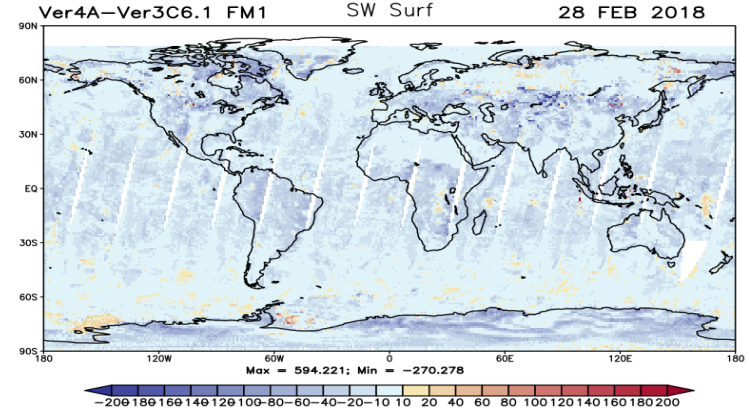
# CERES Terra Daytime Convolved SSF v4A: SW



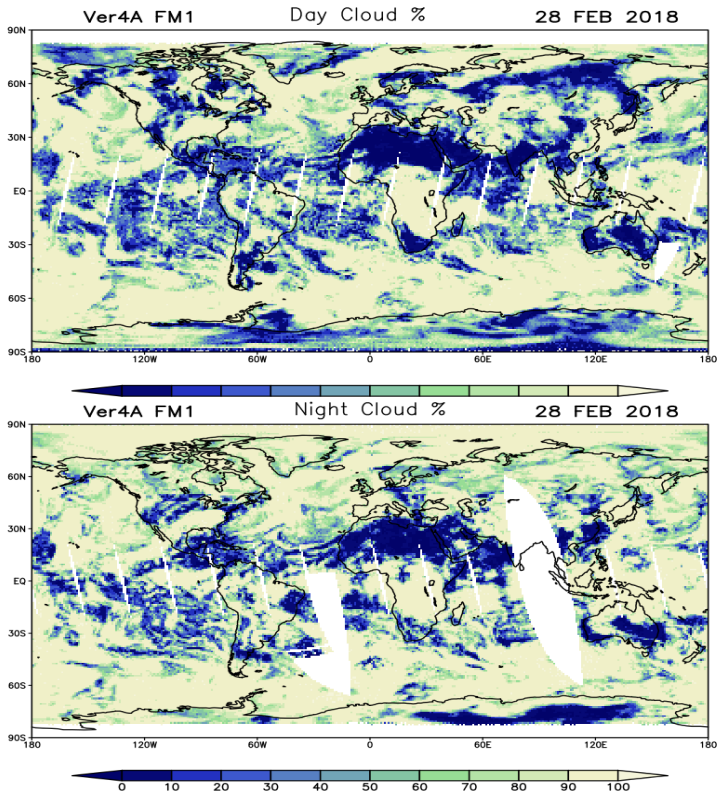

Global Avg.
+0.1 W m$^{-2}$

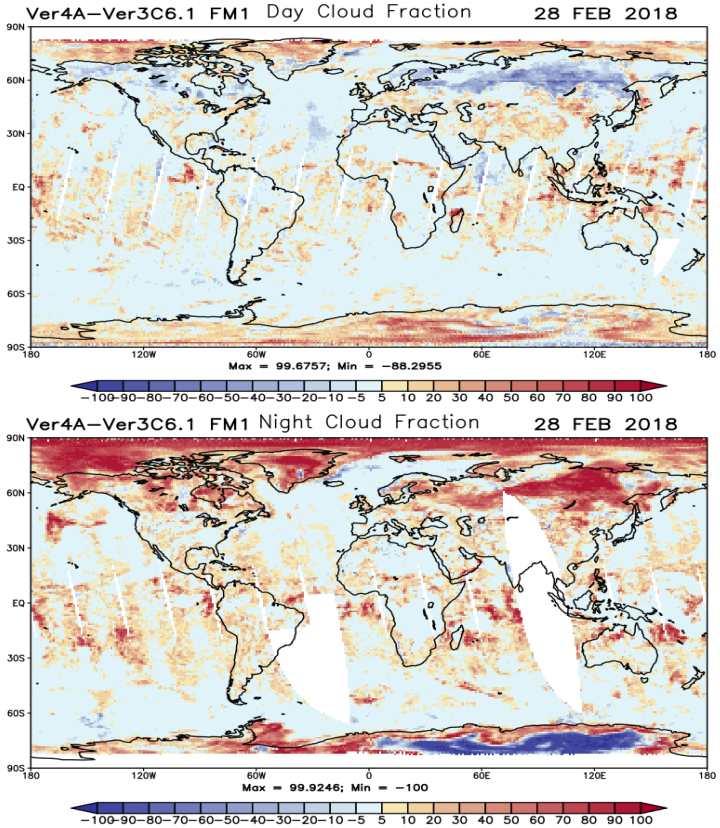



Global Avg.
-13.4 W m$^{-2}$

# CERES Terra Daytime Convolved SSF v4A: Daytime/ Nightime Cloud Fraction

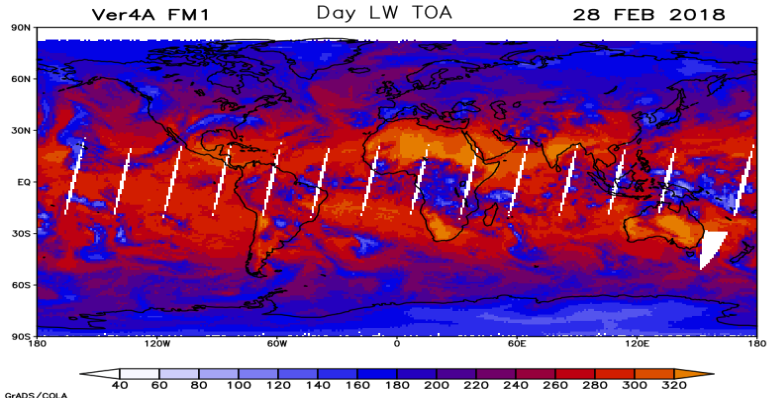


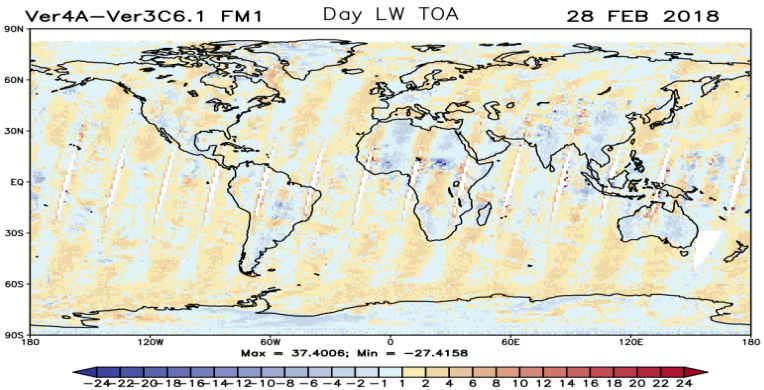




Global Avg. +3.9%

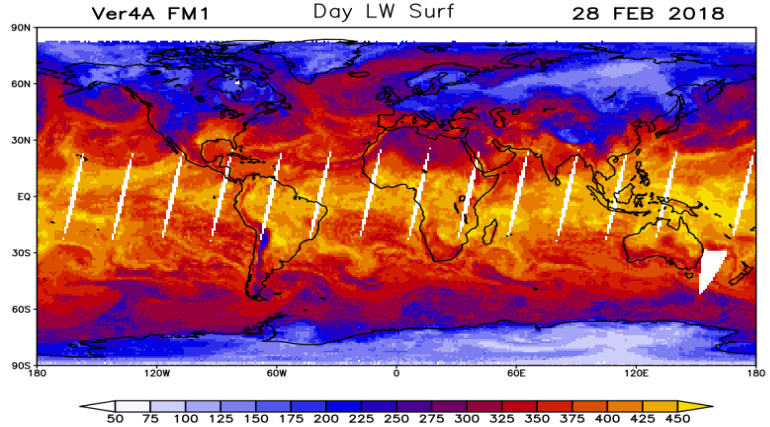
Global Avg. +10.4%

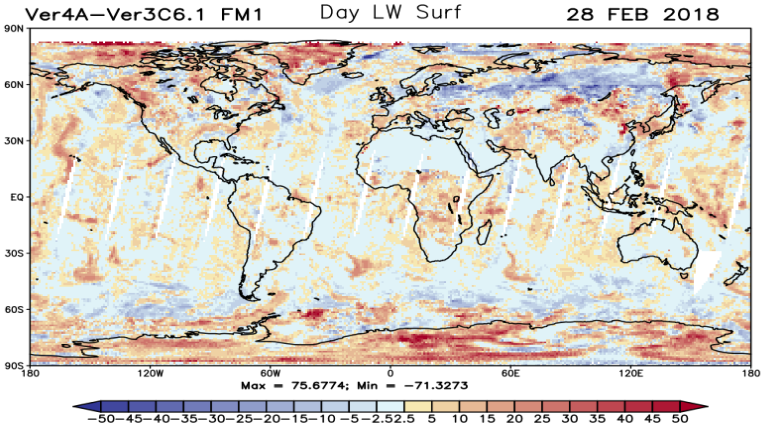
# CERES Terra Daytime Convolved SSF v4A: LW



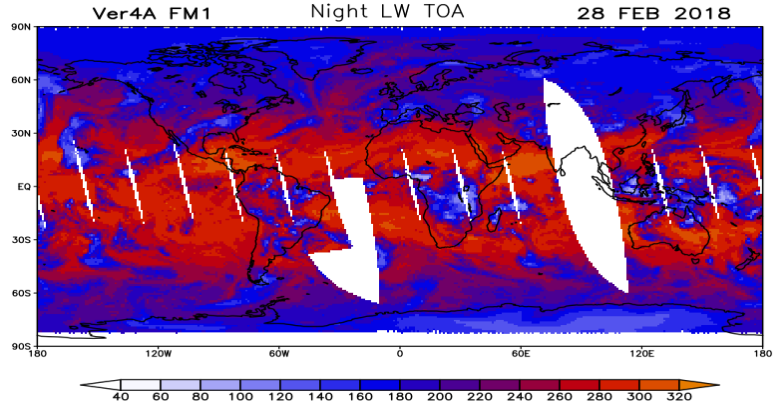

Global Avg.
+0.8 W m$^{-2}$

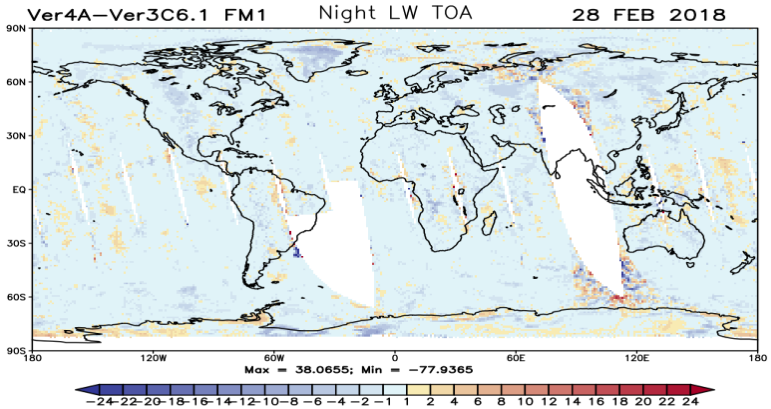


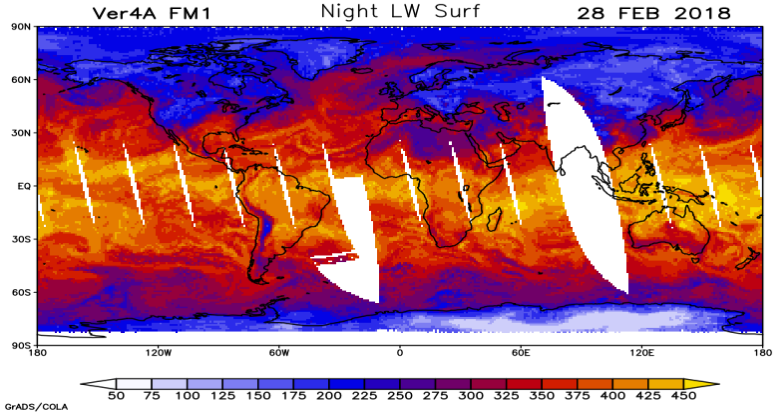

Global Avg.
+3.0 W m$^{-2}$

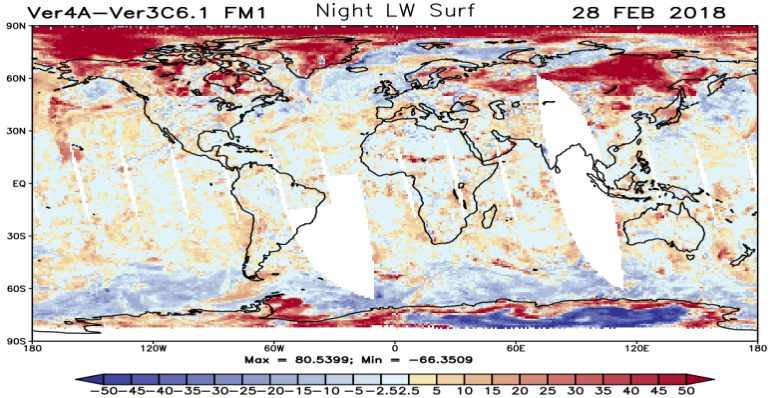
# CERES Terra Nighttime Convolved SSF v4A: LW



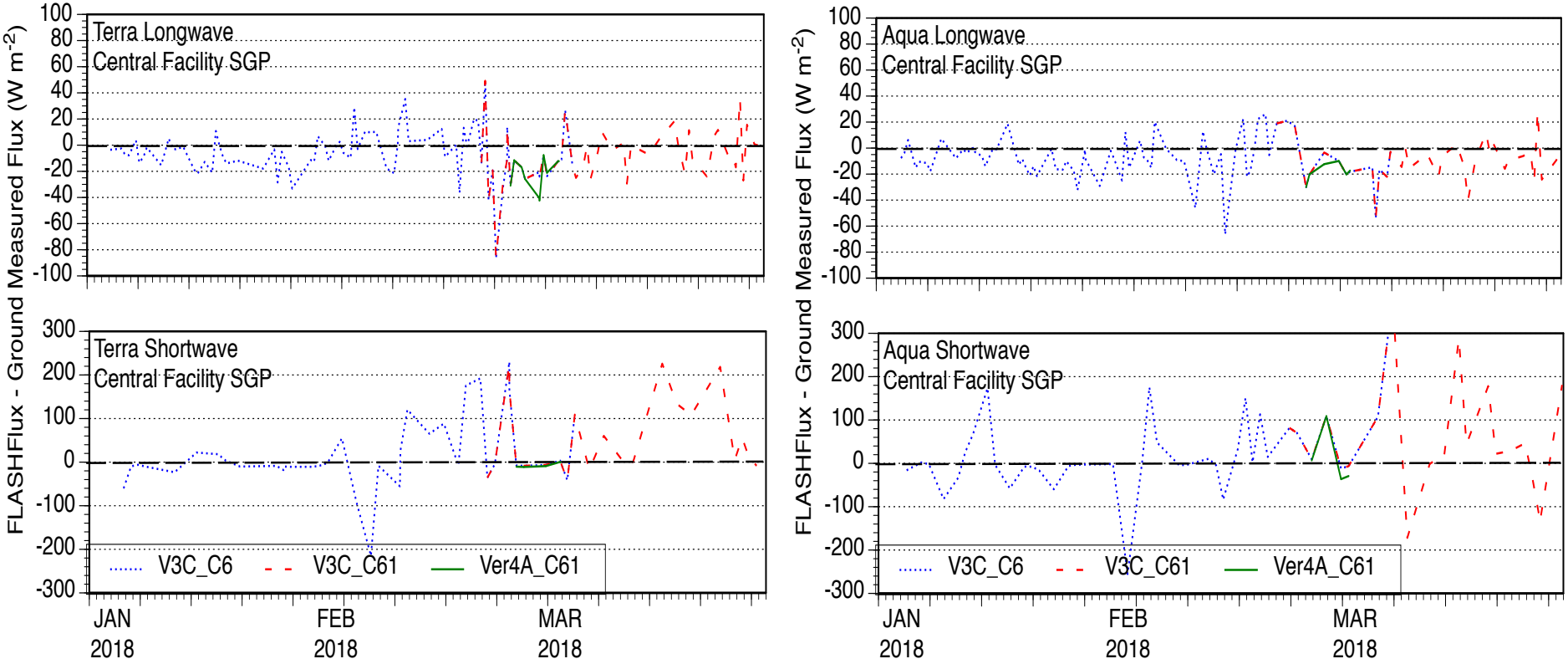

Global Avg.
-0.3 W m$^{-2}$



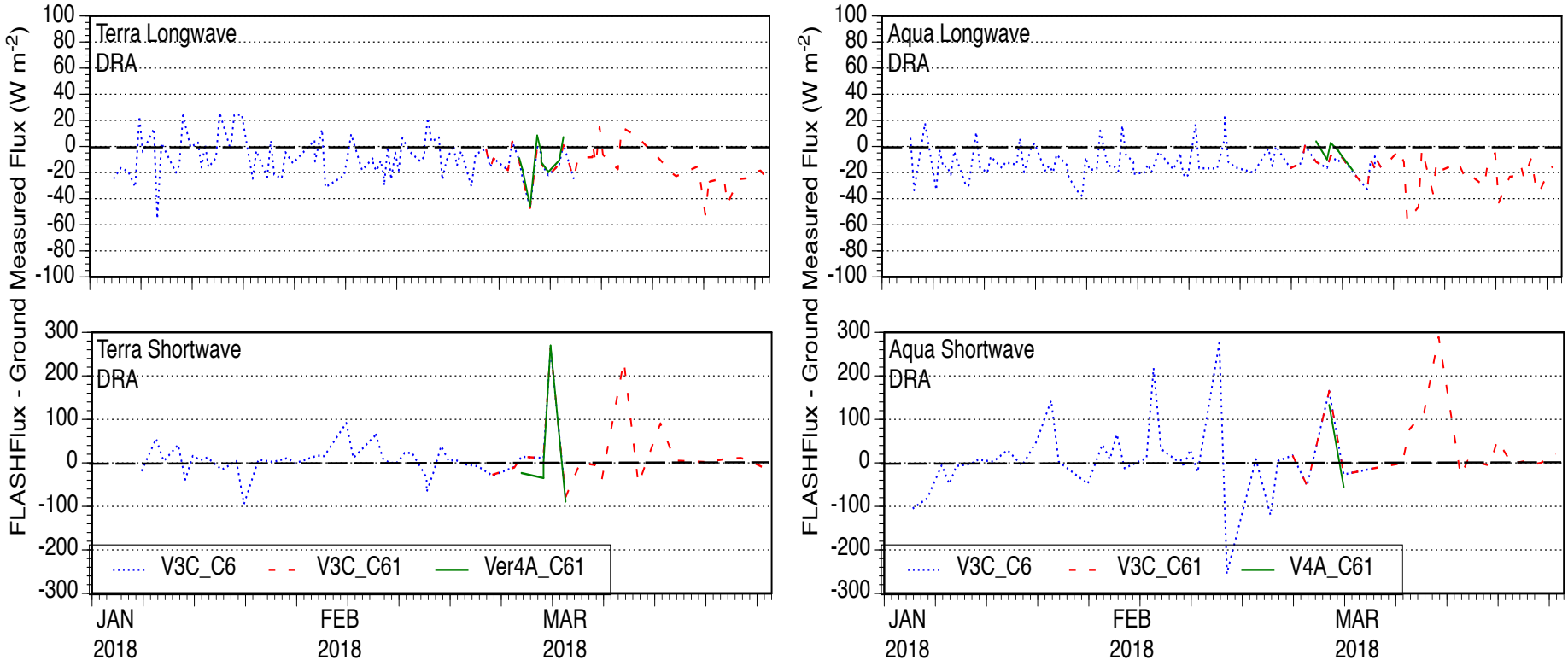




Global Avg.
+3.7 W m$^{-2}$

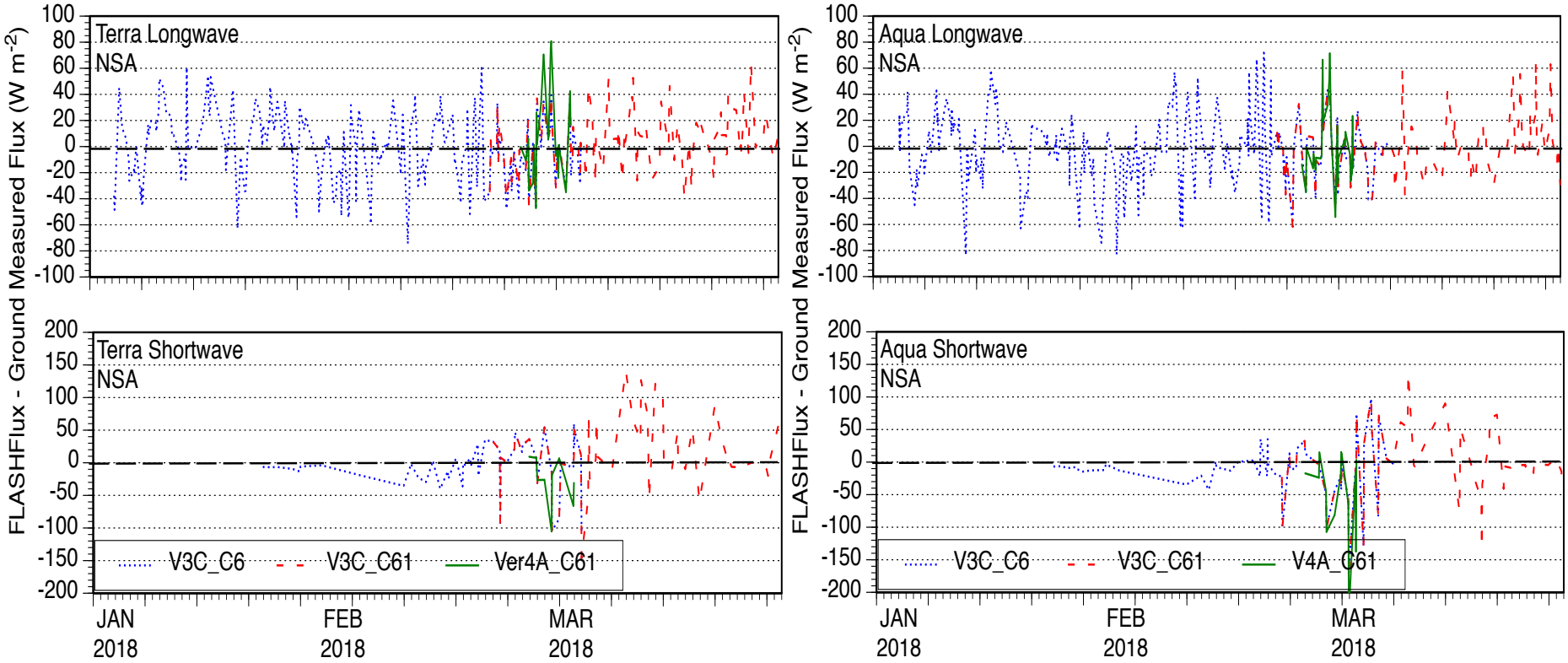
# SSF Overpass vs BSRN Flux Difference Time Series



# SSF Overpass vs BSRN Flux Difference Time Series

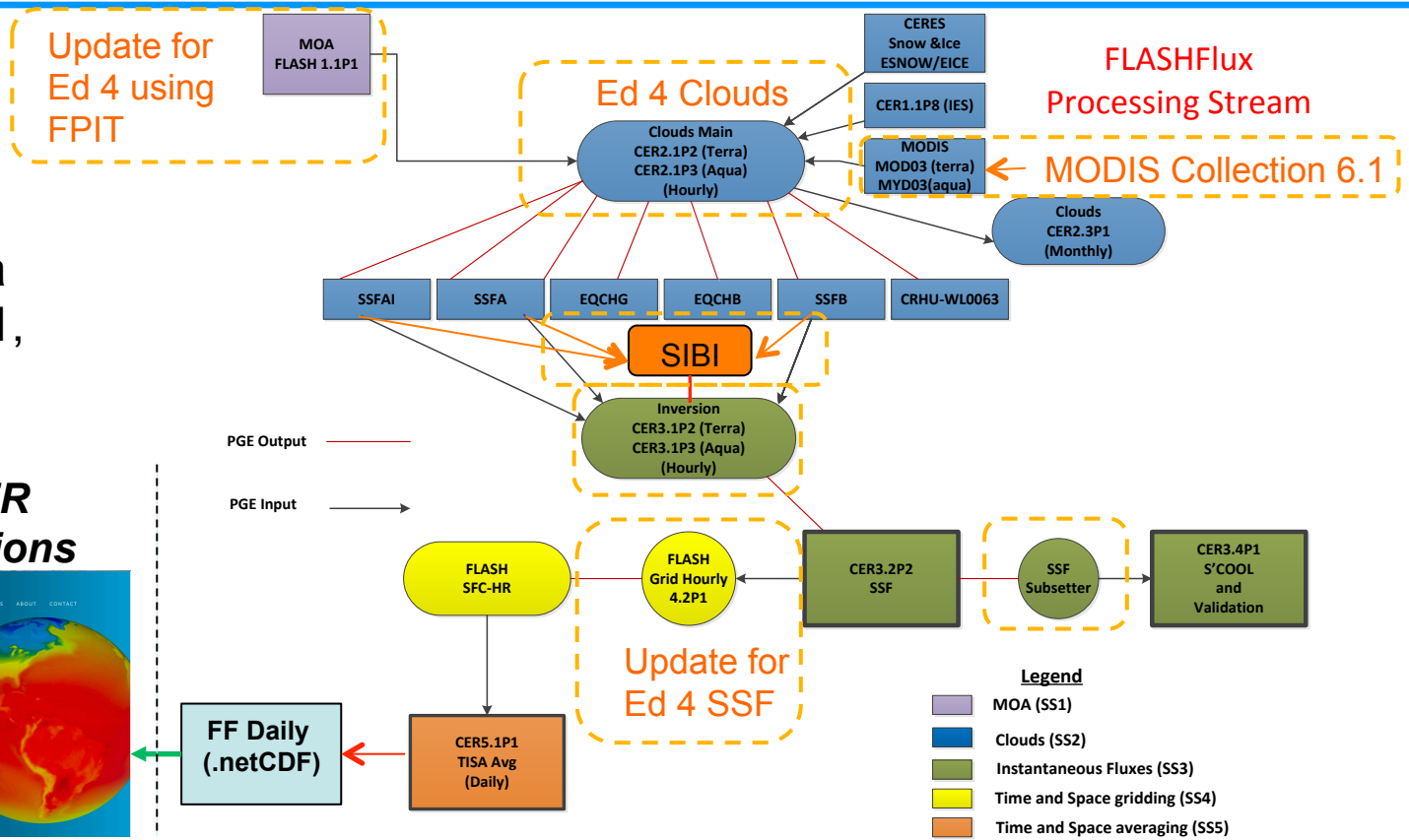


# SSF Overpass vs BSRN Flux Difference Time Series

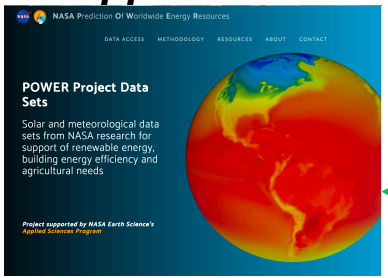


# Planned v4A Production System

Initial data date Jan 1, 2018




## *POWER Applications*



# Summary and Conclusions

- ***FLASHFlux 3C and 4A progress***
  - Transition from v3C (MODIS C6) to v3C MODIS 6.1
  - Developing v4A compatible with CERES Ed 4; will use to MODIS Collection 6.1
  - Evaluating changes to SW MODEL B – solar transmission reduced
- ***FLASHFlux Applications:***
  - New web site featuring GIS tools for CERES/FF/POWER and with ASDC to raise discoverability and accessibility scheduled for release this week!
  - Institutional RETScreen Expert licenses will result in continual usage in large number of US and Canada federal buildings (Johnson Controls), state facilities (HI, MI) and universities (UM, Auburn, Purdue) and corporation facilities (3M)
- ***FLASHFlux publications:***
  - 2017 SotC report submitted
  - Future papers: FLASHFlux TISA applications including energy
- ***Future Versions***
  - Developing v4A by migrating CERES Ed 4 Clouds (collection 6.1) and Inversion; must adapt current FF TISA => target June ‘18
  - Longer-term Upgrades (Summer ‘18): Refine SW Model B, Assess & adapt CERES TSI to FLASHFlux TISA, Assess FPIT aerosol assimilation; NPP SSF

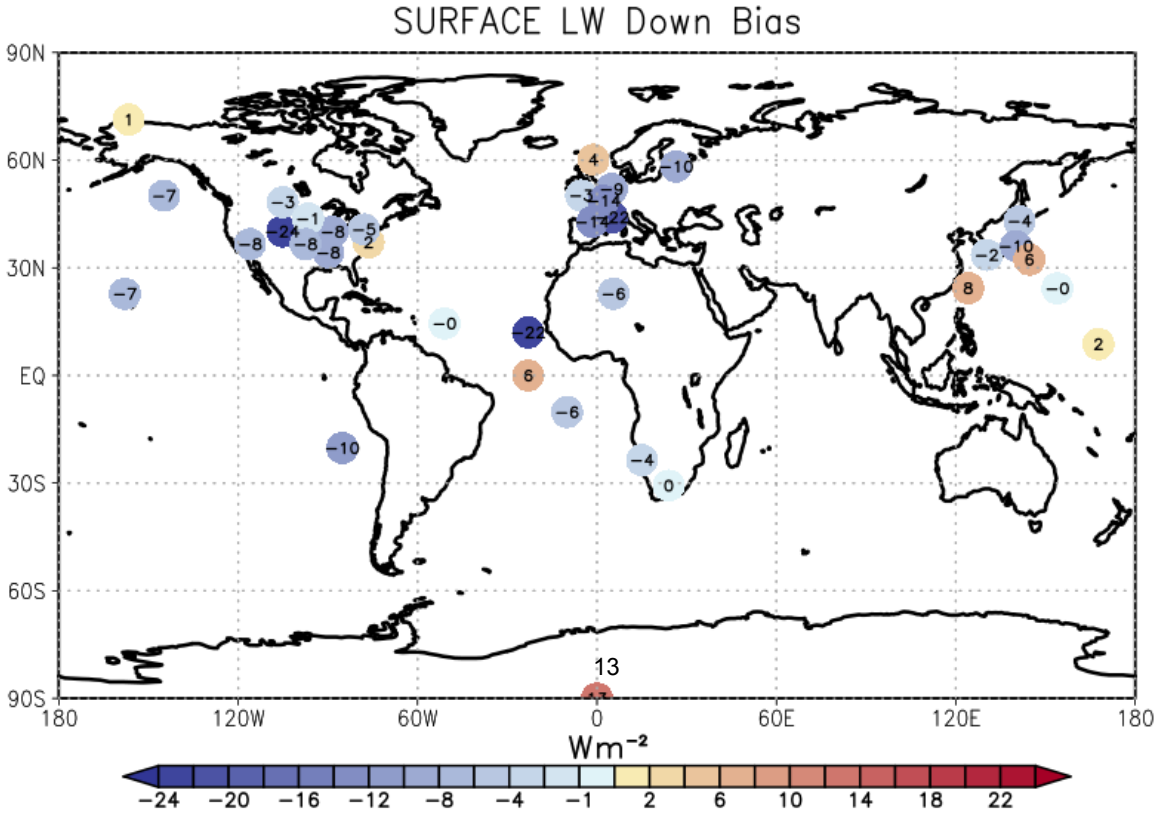
# FLASHFlux Web Sites:

**https://flashflux.larc.nasa.gov**

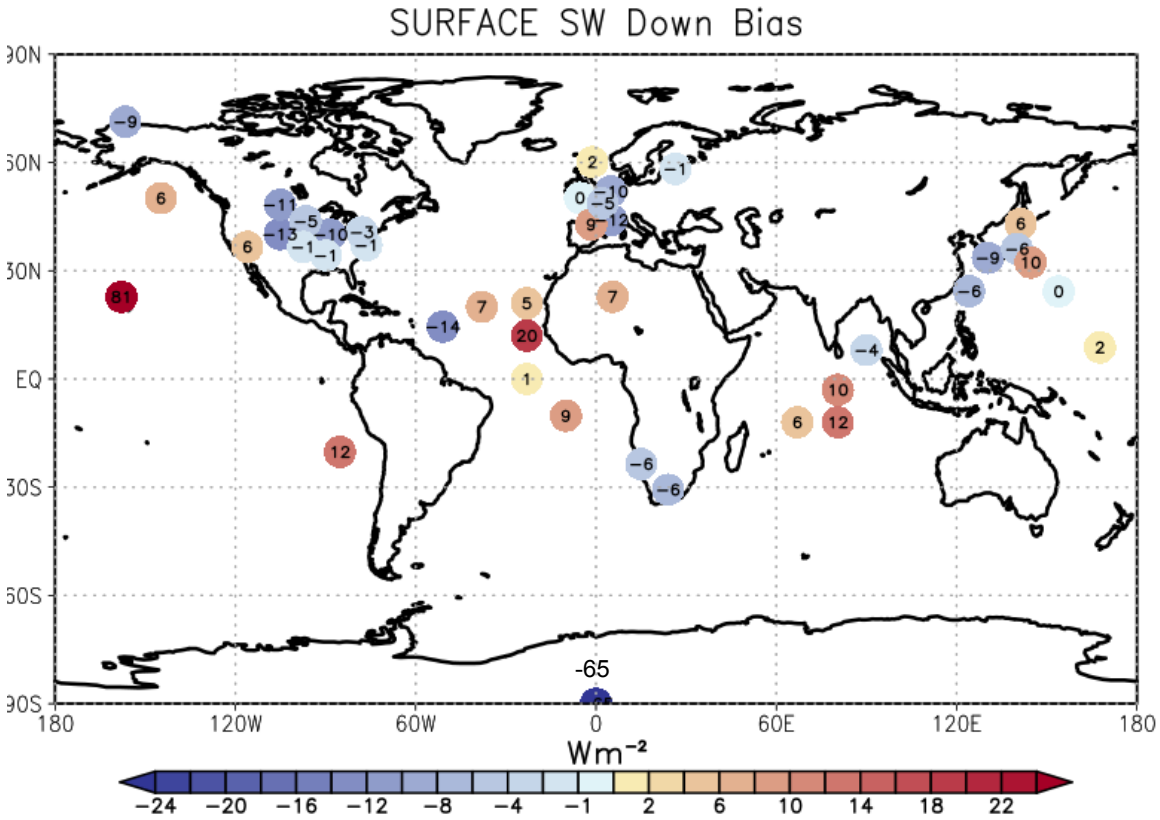
**https://power.nasa.gov & https://power.nasa.gov/new (in Beta)**

# Extras

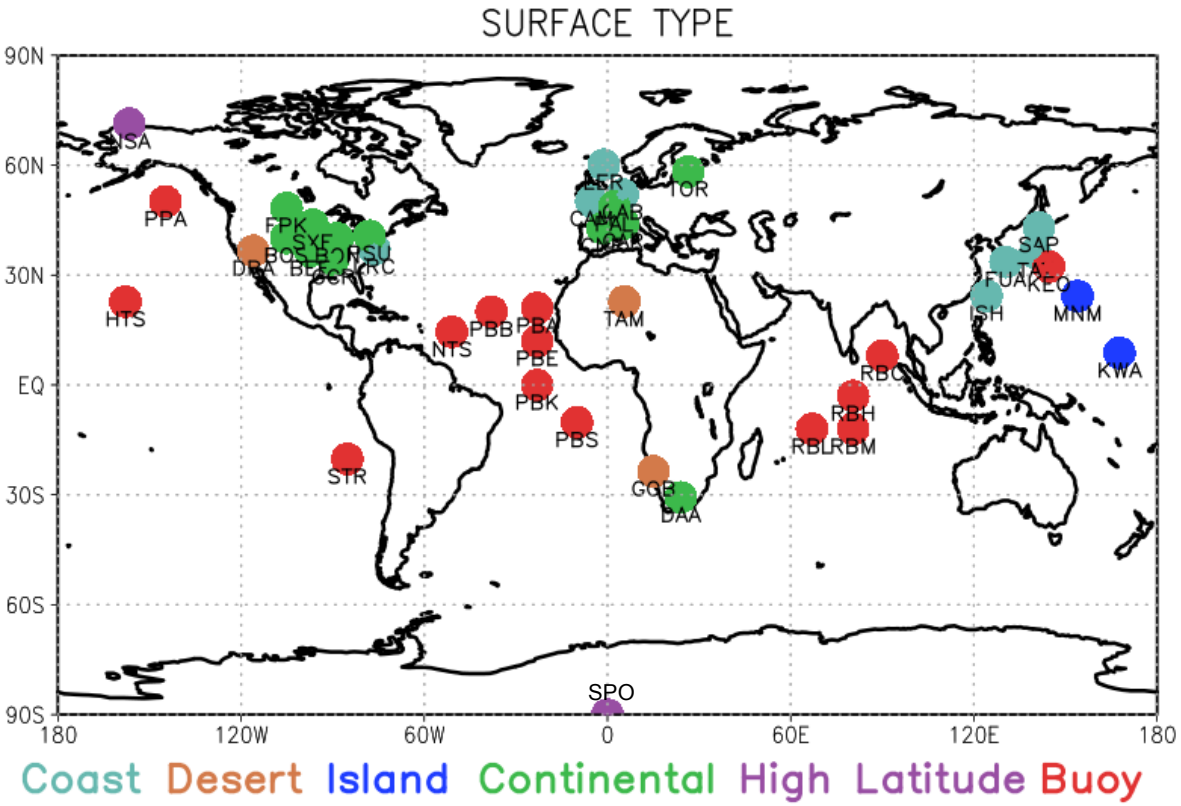
# Recent LW Validation: 1/2017 –7/2017



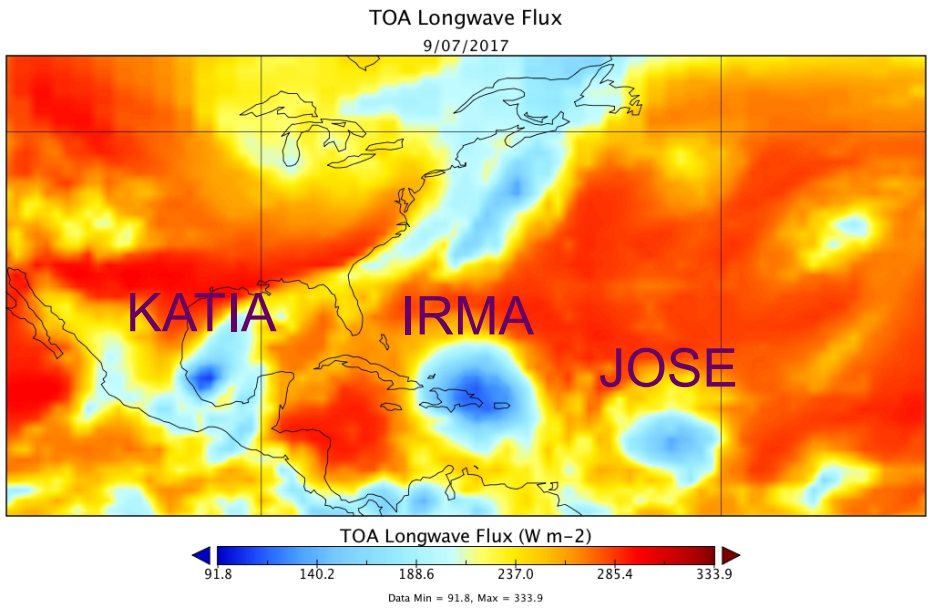
# Recent SW Validation: 1/2017 –7/2017

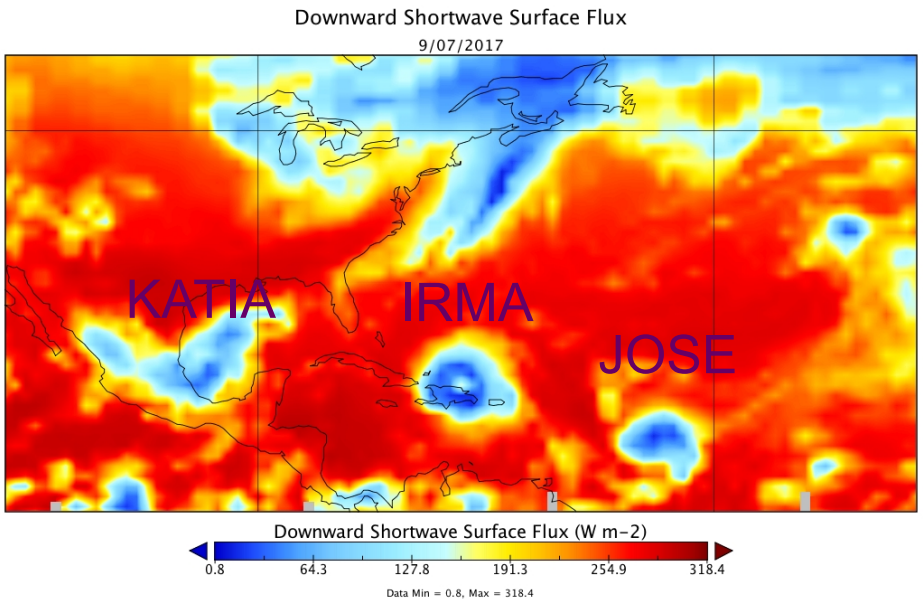


# Validation Sites 1/2017 –7/2017

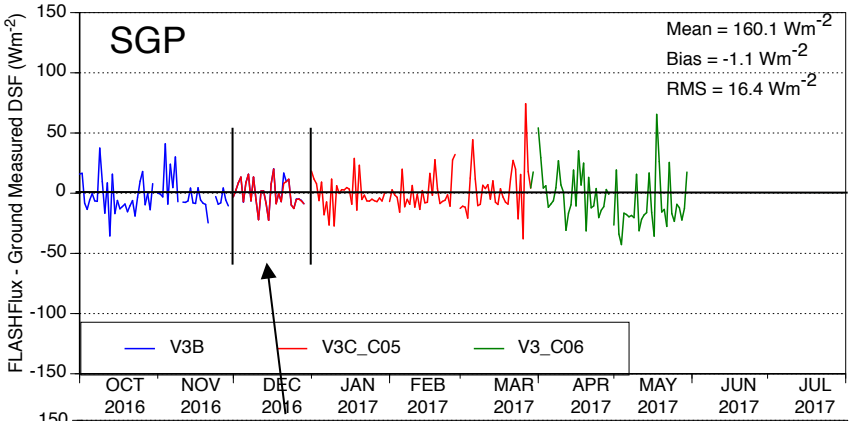


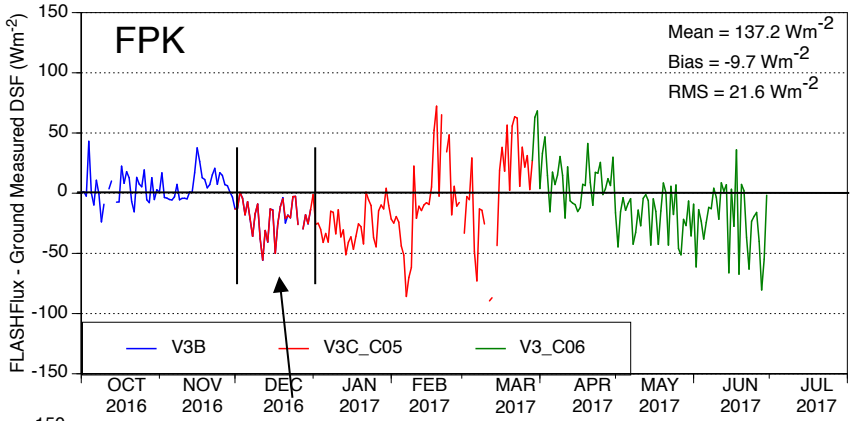
# Daily Time Series: Hurricanes Irma, Jose and Katia

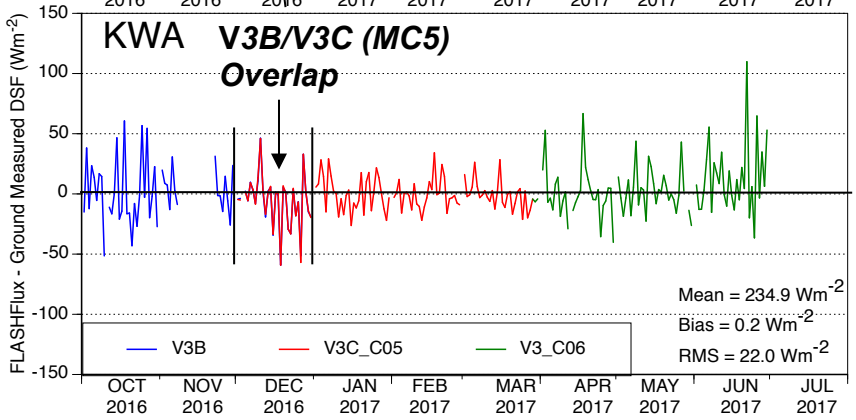


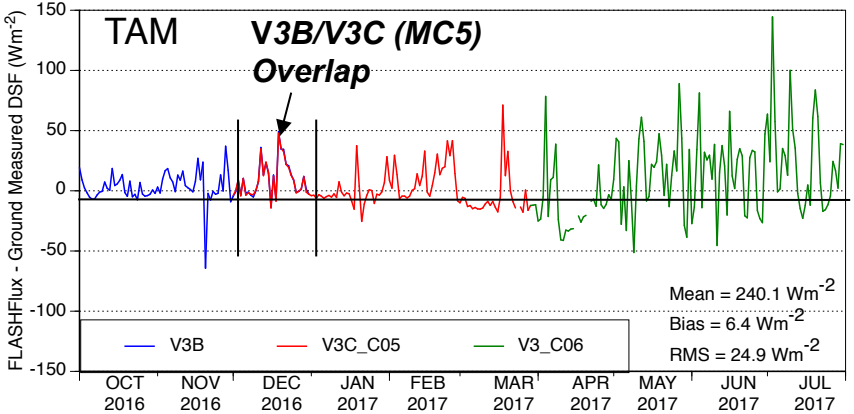
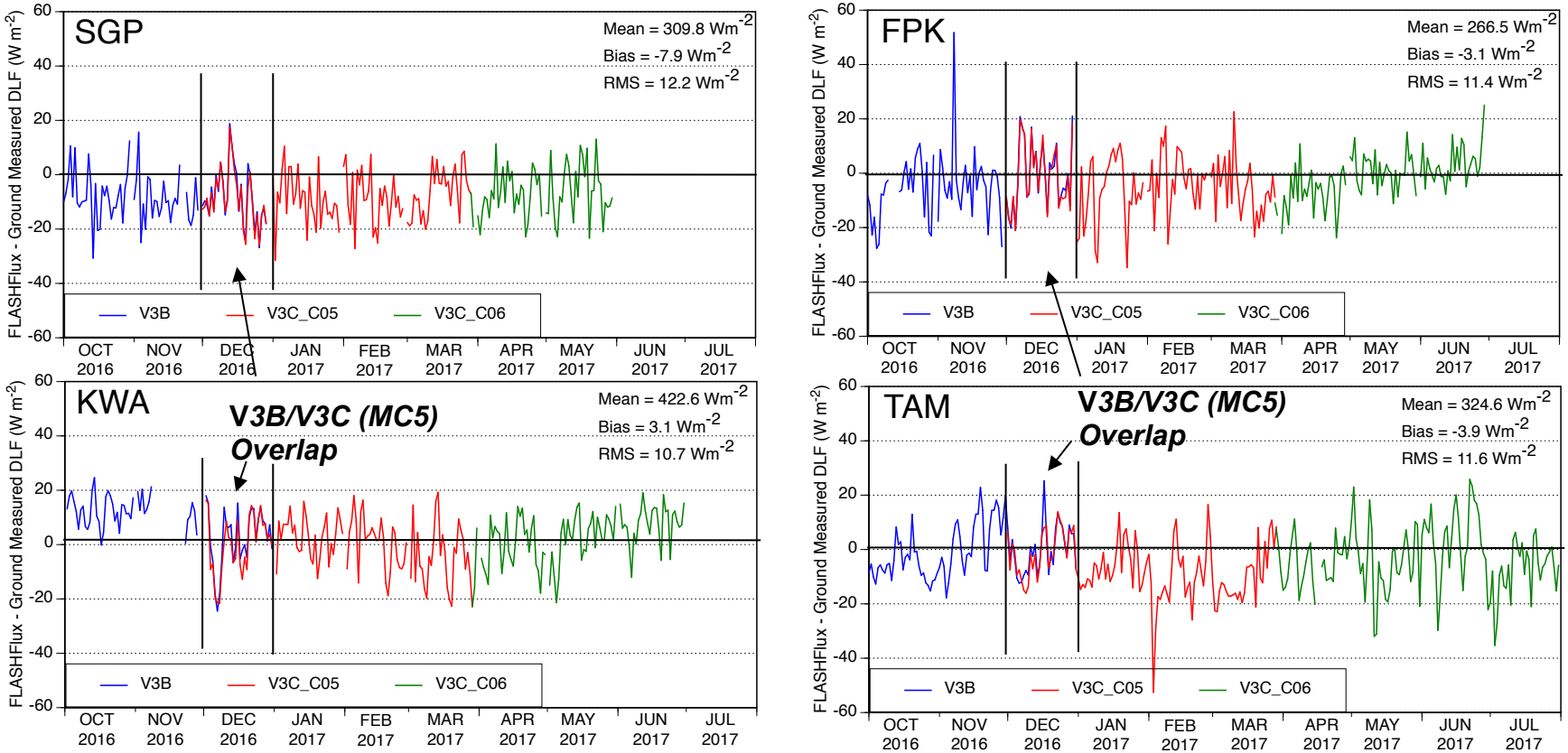



# Multi-Version Difference Time Series: SW






# Multi-Version Difference Time Series: LW